Research Article

Impact of Ash Pond on the Groundwater Quality In The Vicinity Of a Coal –Based Thermal Power Plant

Padmavathi Papolu[1]*, Jyotsna Cherukuri[1] and M Anji Reddy[2]

[1]Department of Humanities and Sciences, VNR Vignana Jyothi Institute of Engineering and Technology, Hyderabad, India
[2]Director, R&D, JNTUH, Professor, Center for Environment, JNTUH-Hyderabad, India

Abstract

Ground water is very precious for the living organisms on the earth. Presence of water pollutants in higher quantities contaminates the ground water quality. Emissions from coal-based thermal power plants show impact on the environment. Huge amount of bottom ash generated due to burning of coal is made into water slurry and pushed into the ash pond affects the ground water and surface water quality. This paper discusses the impact of ash pond of Dr. NTTPS thermal power plant on ground water quality Fresh water samples from the selected sampling sites near the ash pond are collected and the major physico-chemical parameters are analyzed. From the values recorded in all the three seasons, it is found that in Ibrahimpatnam, Mulapadu and Keleswarapuram sampling sites which are closely situated to the ash pond areas, ground water quality is affected and is not fit for drinking purpose without treatment. High amount of TDS and total hardness is recorded in Ibrahimpatnam and Mulapadu areas while heavy metal ions are within the WHO limits.

Keywords: Thermal power plant, ash pond, water bodies, contaminants, ground water quality

***Correspondence**

Author: Padmavathi Papolu
Email: padmavathi_p@vnrvjiet.in

Introduction

Thermal power plant emissions effect the environment and leads to air and water pollution. Presence of water pollutants in higher quantities contaminates the ground water quality. Depending upon the type of industries near the water bodies water quality changes. According to Bindu and Selvamohan [1] most of the ground water samples collected in the Dharmapuram panchayat are having the physico-chemical parameters within the maximum limits. It was also found by Chauhan [2] that the contamination of heavy metals in sediments of river increases with decrease in rate of flow of water. Aftab Begum et al., [3] observed that effluents from a fertilizer manufacturing factory is affecting the water quality. Agarwal and Animesh [4] calculated the extent of water pollution based on the amount of physico-chemical parameters in water samples. A major environmental problem associated with the use of coal as fuel in thermal power plants, is the pollution of ground water. Heavy metals present in the ash generated may affect the soil and water properties. A detailed information [5] about the assessment and management of water pollution was given by Karanth [6] in his book in 1987. Indian thermal power plants consume on an average 80 cubic metre of water for every MWh of power generation, while it is just 10 cubic meter/MWh globally. About 150 liters of water is required per unit of electricity production which is equal to the domestic requirement for a big city. Thermal power project pollution may change the drinking water standards. According to BIS standards pH range of drinking water is 6.5 to 8.5.Varada et al., [7] studied the impact of thermal power plant in the surface water and ground water.

The disposal of fly ash from coal fired power generation plant and its possible impacts on the environment has been a serious environmental problem. Fly ash from the stacks contains traces of alkali and alkaline earth metals and fly ash leach ate in ash pond is observed by Mehra et al., in 1998 [8]. The fly ash is disposed off into landfills. The final fly ash effluents are sent into a natural aquatic river. These methods result in metal contamination of surface and groundwater resources and hence can transfer these contaminants into the food chain. In addition a huge amount of bottom ash is generated due to burning of coal. It is made into water slurry and pushed into the ash pond. This leads to the contamination of ground water [9]. Water slurry contains harmful heavy metals like Cr, Cd, Hg which will leach out into the water table over a period of time. The ground water gets polluted and is not fit for domestic use [10, 11].

Another factor that effects water environment is diverting the ash pond decant into the nearby local water bodies. When this water mixes with a water body, it increases the turbidity of the water thereby decreasing the primary productivity. This is harmful to the fisheries and other aquatic biota in the water body. The ash pond leach ate has impurities like heavy metals lead, mercury, cadmium and arsenic bring changes in the physico-chemical parameters

of the ground water. This paper concentrates on the study of ground water quality in the villages present in the vicinity of a coal based thermal power plant Dr.NTTPS (Dr.Narla Tatha Rao Thermal Power Station) situated in the Krishna district of Andhra pradesh state in India. Since River Krishna is far from the study impact of fly ash from Dr.NTTPS is not having any impact on it. Only ground water quality of various villages located in the close vicinity of Dr.NTTPS is analyzed.

Methodology

A huge ash pond of 1000 acres shown in **Figure 1** is located at about 7 km from the Dr.NTTPS thermal power plant. This ash pond is designed with a decantation filter to filter off the suspended solid impurities. Sprinklers are arranged to settle the fly ash particles from getting mixed into the air. Fly ash and bottom ash from the power plant are mixed with water in the ratio of 1 part ash and 4 to 20 parts of water to form a slurry. The water slurry is then used to push the ash generated during combustion of coal to the ash pond. The ash slurry thus formed is pumped with force into the pipelines which are laid up to the ash pond.

Figure 1 Ash pond Located at 7 km distance from NTTPS with Decantation filter in the Center of the pond

Sampling Sites Selected Near the Ash pond Area

Four sampling sites namely, Jupidi, Ibrahimpatnam, Keleswarapuram and Mulapadu villages which are located within 2-5 kms distance from the ash pond area are selected to determine the quality of ground water. Fresh water samples from the selected sampling sites are collected and the major physico-chemical parameters are analyzed. Seasonal analysis of all the ground water samples collected from four different sites is given in the **Tables 1-5**.

Results and Discussions

Sample Site-1:Jupidi Village

The results obtained by the analysis of the ground water samples collected in Jupidi village are given in the following Table 1.

Ground water samples are collected in the Jupidi village area which is located at a short distance of 2 km to the ash pond. Higher pH value of 8.3 is recorded in the monsoon season. The highest TDS value 1385 mg/L is recorded in summer season. Higher COD and BOD values 63 mg/L and 5.3 mg/L respectively are recorded in monsoon season. Total hardness of about 398 mg/L is recorded in summer which is higher than that recorded in monsoon and winter season. Chloride content is also higher in summer than in the monsoon and winter season. Among the heavy metals mercury is traced more in summer, while lead, mercury and nickel are not traced in monsoon. A little excess amount of chromium is found in the samples collected in monsoon and winter seasons. Copper is found in traces in all the three seasons. From the annual mean, it is found that in Jupidi village ground water samples, pH and TDS are within the WHO standards while COD, BOD and total hardness are exceeding the permissible limits. Chloride content and heavy metals are within the permissible limits.

Table 1 Seasonal Analysis of Ground Water Sample in Jupidi Village

Parameter	Summer	Monsoon	Winter	Mean	WHO standard limits	
					Desirable	Permissible
pH	7.05	8.30	8.0	7.71	7.0-8.5	6.5-9.5
TDS mg/L	1385	532	572	475.66	500	1500
COD mg/L	24	63	22	36.33	10	20
BOD mg/L	3.0	5.3	2.0	3.4	3.0	5.0
Total hardness mg/L	398	357	364	373	300	600
Chlorides mg/L	140	73	95	102.66	250	1000
Lead mg/L	0.0001	Nil	0.031	0.01	0.05	0.01
Chromium mg/L	*BDL	0.184	0.012	0.065	0.05	no relaxation
Mercury mg/L	0.0001	Nil	Nil	0.00003	0.001	0.006
Cadmium mg/L	0.008	0.001	0.002	0.003	0.01	0.03
Nickel, mg/L	0.013	Nil	0.021	0.018	0.01	0.02
Copper, mg/L	0.002	0.0001	0.001	0.001	0.03	0.05

*BDL- Below detectable limit

Sample Site -2 Ibrahimpatnam Village

The results obtained by the analysis of the ground water samples in Ibrahimpatnam area is given in Table 2.

Table 2 Seasonal Analysis of Ground Water Samples in Ibrahimpatnam Village

Parameter	Summer	Monsoon	Winter	Mean	WHO standard limits	
					Desirable	Permissible
pH	7.0	8.72	8.01	7.91	7.0-8.5	6.5-9.5
TDS mg/L	585	1630	1520	1245	500	1500
COD mg/L	18	35	32	28.3	10	20
BOD mg/L	2.0	5.0	3.2	3.4	3.0	5.0
Total hardness mg/L	375	326	352	351	300	600
Chlorides mg/L	75	150	184	136.33	250	1000
Lead mg/L	0.0001	Nil	0.036	0.012	0.05	0.01
Chromium mg/L	0.01	0.001	*BDL	0.003	0.05	no relaxation
Mercury mg/L	0.001	Nil	Nil	0.0003	0.001	0.006
Cadmium mg/L	0.008	0.001	0.002	0.0036	0.01	0.03
Nickel mg/L	0.017	0.015	0.016	0.048	0.01	0.02
Copper mg/L	0.09	0.001	*BDL	0.030	1.5	0.05

*BDL- Below detectable limit

From the water samples collected in the Ibrahimpatnam area which is located at a distance of 4 km from the ash pond, a higher pH value of 8.7 is recorded in the monsoon season. The highest TDS value of 1630 mg/L is recorded in the summer season. Higher COD and BOD values of 35 mg/L and 5.0 mg/L, respectively, are recorded in the monsoon season. Total hardness of about 375 mg/L is recorded in the summer which is higher than that recorded in the monsoon and winter seasons. Chloride content is also higher in summer than that in monsoon and winter seasons. From the annual mean, it is found that in Ibrahimpatnam ground water samples, pH and total hardness are within the WHO standards, while TDS, COD and BOD are exceeding permissible limits in the monsoon and winter seasons. Chloride content and heavy metals are within the permissible limits. Mercury is found in traces in summer.

Sample Site -3 Keleswarapuram Village

From the water samples collected in the Keleswarapuram village which is located at a distance of 3 km to ash pond, a higher pH value of 7.93 is recorded in the monsoon season. The highest TDS value of 730 mg/L is recorded in the summer season. Higher COD and BOD values of 9 mg/L and 2.5 mg/L respectively are recorded in the monsoon season. Total hardness of about 425 mg/L is recorded in the summer which is higher than that recorded in the monsoon and winter seasons. Chloride content is higher in winter than that in monsoon and summer seasons. Among the heavy metals mercury is traced only in summer, while lead and mercury are not traced in monsoon.

Chromium is found in the samples collected in all the three seasons. Copper is found in traces in the summer and monsoon seasons. From the annual mean it is found that in the Keleswarapuram ground water samples pH is above the desirable limits. Total hardness and TDS is above desirable limits,

Table 3 Seasonal Analysis of Ground Water in Keleswarapuram Village

Parameter	Summer	Monsoon	Winter	Mean	WHO standard limits	
					Desirable	Permissible
pH	6.83	7.93	7.0	7.31	7.0-8.5	6.5-9.5
TDS mg/L	730	565	695	663.33	500	1500
COD mg/L	8	9	11	9.3	10	20
BOD mg/L	1.0	2.5	1.2	1.23	3.0	5.0
Total hardness mg/L	425	345	310	360	300	600
Chlorides mg/L	75	66	90	77	250	1000
Lead mg/L	0.0001	Nil	0.026	0.008	0.05	0.01
Cmium mg/L	0.004	0.001	0.002	0.002	0.05	no relaxation
Mercury mg/L	0.005	Nil	Nil	0.001	0.001	0.006
Cadmium mg/L	0.008	0.001	0.002	0.003	0.01	0.03
Nickel mg/L	0.018	0.010	0.012	0.049	0.01	0.02
Copper mg/L	0.01	0.012	*BDL	0.007	0.03	0.05

*BDL- Below detectable limit

Table 4 Seasonal Analysis of Ground Water in Mulapadu Village

Parameter	Summer	Monsoon	Winter	Mean	WHO standard limits	
					Desirable	Permissible
pH	6.69	7.25	6.81	7.71	7.0-8.5	6.5-9.5
TDS mg/L	1017	862	845	475.66	500	1500
COD mg/L	140	142	95	125	10	20
BOD mg/L	30	45	19	31.3	3.0	5.0
Chlorides mg/L	95	90	102	95.6	300	600
Total hardness mg/L	485	367	295	382.	250	1000
Lead mg/L	0.02	BDL	0.01	0.01	0.05	0.01
Chromium mg/L	0.04	0.001	0.01	0.02	0.05	no relaxation
Mercury mg/L	0.002	BDL	0.001	0.001	0.001	0.006
Cadmium mg/L	0.008	0.001	0.002	0.003	0.01	0.03
Nickel mg/L	0.009	0.005	0.007	0.007	0.01	0.02
Copper mg/L	0.03	0.001	0.03	0.02	0.03	0.05

*BDL- Below detectable limit

Sample Site -4 Mulapadu Village

From the samples collected in the Mulapadu village which is located at a distance of 2 km to ash pond, a higher pH value of 7.25 is recorded in the monsoon season. The highest TDS value of 1017 mg/L is recorded in the summer season. Higher COD and BOD values 142 mg/L and 45 mg/L respectively are recorded in the monsoon season. Total hardness of about 485 mg/L is recorded in summer which is higher than that recorded in the monsoon and winter seasons. High Chloride content of 90 mg/L is recorded in the winter than that in the monsoon and summer seasons. Among the heavy metals, mercury is traced in summer and winter seasons, while lead and mercury are not traced in the monsoon. Chromium and copper are found in the samples collected in all the three seasons. From the annual mean it is found that in Mulapadu ground water samples, pH and total hardness are above the desirable limits, while COD and BOD are exceeding WHO standards in all the seasons. Chloride content and heavy metals are in the threshold levels.

The experimental results obtained from the analysis of ground water samples collected from the sampling sites is summarized as follows in the **Figure 2**.

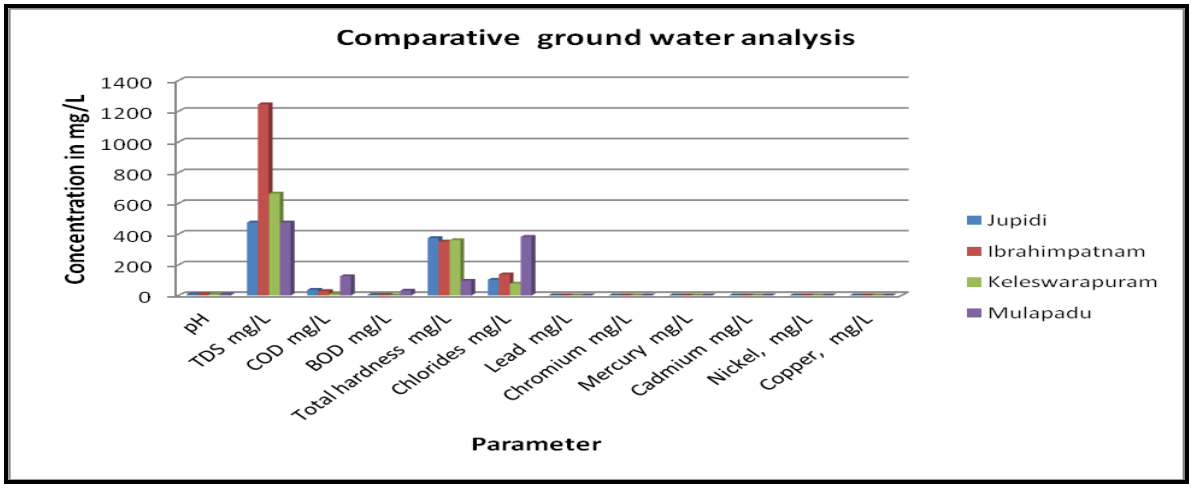

Figure 2 Comparative Results of Ground Water Analysis

Conclusions

It is thus concluded that ash pond is showing some measurable impact on the drinking water quality in the villages surrounding the ash pond. On average in all the sampling sites, pH of the water samples is found to be slightly above the BIS (Bureau of Indian Standards) [12] standard 6.5 to 8.5. Presence of higher TDS and hardness causing salts does not give lather with soap and also make the water not suitable for bathing and washing. On average total hardness in water samples is above the desirable limit of 300 mg/L. Comparatively water samples collected from Ibrahimpatnam and Mulapadu village which is more closer to ash pond area recorded more hardness of 382 mg/L. Water samples collected from Mulapadu village recorded a high COD value of 125 mg/L indicating the leachate of chemical impurities from the ash pond into the ground water. From the values recorded in all the three seasons, it is found that in Ibrahimpatnam, Mulapadu and Keleswarapuram sampling sites which are closely situated to the ash pond areas, ground water quality is affected and may not fit for drinking purpose in the future. In summer season presence of heavy metals is more due to the evaporation of water.

It is essential that in an industrial area like thermal power plants, regular monitoring of water sources is needed, because they are surrounded by villages and hence can affect the health of local biota [13, 14].

Figure 3 Decanted Water from Ash pond being used for Irrigation

On the positive side the decanted water of the ash pond is utilized for vegetation down the ash pond as shown in **Figure 3**, as it contains some trace elements required for the plant growth. The decanted water coming from the ash pond is found to have the required standards for irrigation.

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